Decision Tree Based Algorithm for Removal of Different Probability Salt and Pepper Noise in Images

Vasanth.K, Shirisha.N, Naveen Kishore Babu

Abstract:
A Decision tree based algorithm for the removal of equal and unequal probability salt and pepper noise in images is proposed. The algorithm aims to address one solution for different salt and pepper noise models. The proposed algorithm operates on an image using fixed 3*3 window. The decision tree based algorithm classifies pixel into noisy or not based on the decision and replaces it with mean of neighbours or unsymmetrical trimmed median or unsymmetrical trimmed midpoint. The algorithm exhibit excellent noise elimination capability at high noise densities in terms of quantitative and qualitative perspective. The algorithm was found to exhibit good noise removal characteristics for three noise models.

Key words: Salt and pepper noise, impulse noise, unequal probability, decision based algorithm.

I. INTRODUCTION

In the process of image acquisition and transmission over the channel, the images are frequently corrupted by way of impulse noise. Impulse noise is of two types. Fixed valued impulse noise and Random valued impulse noise. The fixed valued impulse noise is also referred to as Salt and Pepper noise. That holds ‘0’ (pepper) and ‘255’ (salt) known as salt and pepper noise. Another type of impulse noise is random-valued impulse noise. This influences the corruptive values inside the variety [0, 255]. This is called the dynamic range of the image. There have been more studies that have been finished in image evaluation. The first step in any image processing is that we convey some pre-processing procedures to know whether the picture is original or corrupted with noise. Estimating the noise density in an image could be very crucial and additionally a bit difficult because we do now not, in most cases, do now not know the supply of noise (additionally type of noise). The estimation and filtering of noise (salt & pepper) is one of the critical pre-processing steps within the image processing method. There are many filtering algorithms that we can use for filtering the noise, had been proposed in the past few years. The handiest one available is the Median clear out, one of the consultant filtering algorithms. In recent years, many versions of the median filter having been proposed. Linear filters can dispose of the salt and pepper noise, but it blurs the image. Hence non-linear filters are used for noise elimination. Subhojit Sarker et al [1], Used Non-local mean filter for recuperation and Salt and Pepper Noise removal. The algorithm removes noise at increasing variance as much as 0.7. Algorithm consumes greater computation time. Vijayan [2] used Modified Decision based unsymmetrical trimmed median filter (DBUTMF) for removing of Salt and Pepper Noise. The algorithm works well at 10% to 90% noise density and takes less computation time because of using shear sorting algorithm. Aldunucci et al [3] used Adaptive median filter for eliminating salt and pepper noise and recuperation of Image. Advantages of this filter are High exceptional, edge-retaining, and recuperation. The Disadvantage in this algorithm is High computational price. Firas Ajil Jassim [4] introduced IQR filter is used for salt and pepper noise removal and edge protection, which fits effectively however it fails at growing window size and high noise densities. Elmustafa et al [5] proposed one-of-a-kind median filters have been used and given their overall performance at specific characteristics of the image. Nair et al [6] gave an Improved Decision –Based Algorithm for Impulse Noise Removal, In these images, noisy pixels are changed with the mean or median of neighborhood pixel. Veerakumar et al [7] gave an Approach to minimize very high-density salt and pepper noise through Trimmed Global Mean, Used median and Trimmed global mean for noise elimination. J.Jenifer et al [8], studied different De-noising Techniques Eliminating Impulse noise and Artifacts, Comparisons between special styles of filters. Alias et al [9] removed Salt and pepper noise via the use of Improved Decision-Based Algorithm and replaced the corrupted pixels with median and Midpoint. Selvi and Sukumar [10] used a Model to estimate the salt and pepper noise density level on the grayscale image. This algorithm gave the relation between entropy and noise density. Fareed and Khader [13], proposed an algorithm for salt and pepper noise removal using adoptive and selective mean filter. HosseinKhani et al[14], introduced a filter to remove noise in medical images. VijayKumar et al[15], gave a Switching median Filter for the Removal of Salt and Pepper Noise in Images is proposed. All the algorithm proposed over the years had targeted to remove fixed valued salt and pepper noise of equal probability. Many algorithms had failed to remove noise at high noise densities or creates few artifacts. In the proposed work a decision-based algorithm is used for the elimination of both equal & unequal probability salt and pepper noise. Hence a suitable algorithm has to be designed to remove salt and pepper noise without inducing artifacts. Section 2 deals with the noise model. Section 3 deals with the proposed algorithm. Section 4 offers with simulation and discussions. Section 5 concludes the work.

II . NOISE MODEL

Noise degrades most of the part of image information. Image degradation is a major problem in image processing. Image distorted due to various of noise such as

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***** Correspondence Author
Dr.Vasanth.K*, Professor, VidyaJyothi Institute of Technology, Aziz Nagar, Hyderabad, Telengana, India vkbece@vjit.ac.in, vasanthecek@gmail.com
N.Shirisha, PG Scholar, VidyaJyothi Institute of Technology, Aziz Nagar, Hyderabad, Telengana, India
N Naveen Kumar Babu, CEO, Link Buffer Studios, CANADA

Gaussian noise, Poisson noise, Speckle noise and Salt and Pepper. The paper propose an algorithm for three different noise model whose probability of occurrence was found to be equal and unequal. The various noise model used in the paper is given below.

NOISE MODEL 1: In noise model1 Salt and pepper noise with the equal noise probability are taken into consideration. If [0, 255] denote the dynamic range of y', i.e., zero <= Pij <= 255 for all (i,j), then they are denoted by Salt-and-pepper noise. The gray level of y at the pixel region (i j) is illustrated in equation 1.

Yij= 0 with probability p;
Pij with probability 1-p-q;
255 with probability q; (1)

Where s = p + q denotes the salt-and-pepper noise level [11].

NOISE MODEL 2: In noise model2 Salt and pepper noise with unequal noise probability are taken into consideration. Where white pixels are greater than black pixels: For the Noise Model 2, it's similar to equal probability Noise Model 1, except that each pixel might be corrupted via the greater quantity of "salt" noise than "pepper" noise with unequal probabilities. Let P1 and P2 be the probability of incidence of salt and pepper respectively.

Yij= P1 for X=0;
1-P for X=Pij;
P2 for X=255; (2)

Where X is the noise density P=P1+P2 and P1≠P2 where P1 >P2[12].

NOISE MODEL 3: In noise model3 Salt and pepper noise with unequal noise possibility are taken into consideration with more black pixels than white pixels. For Noise Model three, it's far just like Noise Model 2, might be corrupted via a greater number of "Pepper" noise than "salt" noise with unequal probabilities. Let P1 and P2 be the probability of the occurrence of salt (255) and pepper (zero) respectively.

Yij= P1 for X=0;
1-P for X=Pij;
P2 for X=255; (3)

Where X is the noise density P=P1+P2 and P1≠P2 where P2 >P1 [12].

III. PROPOSED ALGORITHM:

The proposed algorithm is also called as Decision tree based algorithm for removal of salt and pepper noise. The proposed algorithm is elaborated as follows.

Step1: Read the noisy image.

Step2: Choose a 3*3 window.

Step3: Arrange the data in increasing order in an array.

Step4: Perform unsymmetrical trimming of the input array and find the median and midpoint of the input array.

Step5: Check the processed pixel is noisy or not, if the pixel hold 0 or 255 it is considered noisy.

Step6: If noisy pixels are present inside the image then check for noisy neighbors.

Step7: Case (1): If the range of noisy pixels is more than three, the noisy pixels are changed with the unsymmetrical trimmed midpoint.

Case (2): If the range of noisy pixels is less than 3, the noisy pixels are changed with the median.

Case (3): If the processed pixel is noisy and some of the neighbors are noisy then replace with local mean.

Case (4): If the processed pixel is noisy and all of the neighbors are noisy then replace with global mean.

The process is repeated for rest of the images.

IV. SIMULATION RESULTS AND DISCUSSIONS:

The proposed algorithm is evaluated using Mat lab R2015a based totally on quantitative measure PSNR, Mean Square Error (MSE), Image Enhancement Factor (IEF), and Structural Similarity Index Metric (SSIM) are

$$PSNR = 20 \log 10 \left(\frac{2}{M} \right) \quad (4)$$

$$MSE = \sum_i \sum_j \left[\frac{(rij - xi}{M \times N} \right] \quad (5)$$

Processed image.

$$SSIM(x, y) = \frac{(2\mu x \mu y + C1)(2\sigma xy + C2)}{(\mu x2 + \mu y2 + C1)(\sigma x2 + \sigma y2 + C2)} \quad (6)$$

Where μx is the average of x, μy is the average of y, σx is the Standard deviation of x, σy is the Standard deviation of y. C1= $(K_1L)^2$, C2= $(K_2L)^2$ two variables to stabilize the division with vulnerable denominator; L the dynamic range of the pixel values (for an 8 bit image it takes from 0 to 255), K1=0.01 and K2=0.03 via default. MSE is referred to as Mean square error. Matlab R2015a is used for simulations. The computer used is having specifications Intel (R) Core (TM)i3-5005U CPU, 2GHz speed, 4GB RAM and 64-bit operating system.

The experiments were performed using images corrupted by fixed valued impulse noise by adding 10% of it for every execution from 10% to 90%. The unequal probability noises were created using photo shop depending on the size of image pixel count and noise model.

Gray.tiff(PSNR)			
ND	SMF	AMF	DT(PA)
10	39.12	7.53	24.00
20	31.21	10.86	24.01
30	28.79	12.47	24.01
40	26.51	12.96	24.02
50	22.88	12.91	23.99
60	18.02	12.17	23.99
70	13.42	10.72	24.00
80	9.57	8.60	23.92
90	6.73	6.43	18.80

Table 1: Comparisons between various algorithms with Decision tree in terms of PSNR of Synthetic image

Table 2: Comparisons between various algorithms with Decision tree in terms of MSE of Synthetic image

Gray.tiff(MSE)			
ND	SMF	AMF	DT(PA)
10	7.950	1.1465	258.74
20	49.17	5.3264	258.07
30	85.89	3.6780	257.94
40	145.11	3.2858	257.67
50	334.87	3.3238	259.13
60	1.0226	3.9379	259.42
70	2.9540	5.5076	258.69
80	7.1719	8.9747	263.15
90	1.3718	1.4773	855.71

Table 3: Comparisons between various algorithms with Decision tree in terms of SSIM of Synthetic image

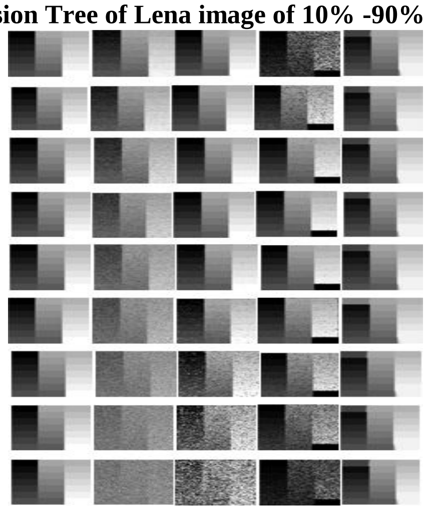
Gray.tiff(SSIM)			
ND	SMF	AMF	DT(PA)
10	0.98	0.05	0.92
20	0.95	0.07	0.92
30	0.91	0.24	0.91
40	0.85	0.58	0.89
50	0.63	0.53	0.87
60	0.24	0.25	0.84
70	0.04	0.07	0.80
80	0.007	0.04	0.75
90	0.001	0.04	0.63

Table 4: Comparisons between various algorithms with Decision tree in terms of IEF of Synthetic image

Gray.tiff(IEF)			
ND	SMF	AMF	DT(PA)
10	277.46	0.185	8.64
20	91.06	0.79	17.12
30	77.69	1.80	25.41
40	61.20	2.75	34.55
50	37.07	3.37	42.86
60	12.98	3.48	51.12
70	5.25	2.86	60.08
80	2.48	1.98	67.47
90	1.44	1.35	23.35

a) Original b) Corrupted c) Restored SMF d) Restored AMF e) Restored DT(PA)

Fig 1: Comparisons between SMF &AMF with Decision Tree of Lena image of 10% -90% noise



a) Original b) Corrupted c) Restored SMF d) Restored AMF e) Restored DT(PA)

Fig 2: Comparisons between SMF &AMF with Decision Tree of Synthetic image of 10% -90% noise

From the noise model 1, Table 1 shows the quantitative results of the proposed algorithm in the form of PSNR, When in comparison to SMF and AMF the proposed decision tree based algorithm putting off noise efficiently. From Table 2 it is illustrated that the proposed algorithm gives less error possibility results in the form of MSE. From Table 3 proposed algorithm offers excellent preservation of structure in the form of SSIM, and from Table 4 it is proved that the proposed algorithm gives quantitative results in the form of IEF of Synthetic image. From Table 1, Table 2, Table 3 and Table 4 it is illustrated that the proposed algorithm offers qualitative effects within the form of PSNR, MSE, SSIM, and IEF.

Figure 1 is the qualitative evaluation of the proposed algorithm when noise density from 10% to 90% of the Lena image when as compared with SMF and AMF. Figure 2 is the qualitative analysis of the proposed algorithm while noise from 10% to 90% of the Synthetic image when as compared with SMF and AMF. From the above figures, Figure 3 is having greater white pixels, which having noise densities from 10% to 90% and qualitative restored pixels after noise removal by the usage of Decision Tree-based algorithm. From the noise model 3, Figure 4 is having greater black pixels, which having noise densities from 10% to 90% and given qualitative restored images after noise removal.

The replacement of noisy pixel was done using mean of 4 neighbors, unsymmetrical trimmed median and unsymmetrical trimmed midpoint. These values operate only on non noisy pixels and these values were found to lie between mean and median. Hence Decision based approach in replacing a suitable pixel for the corrupted pixel using the above statistics is the main reason for good result even at high noise densities

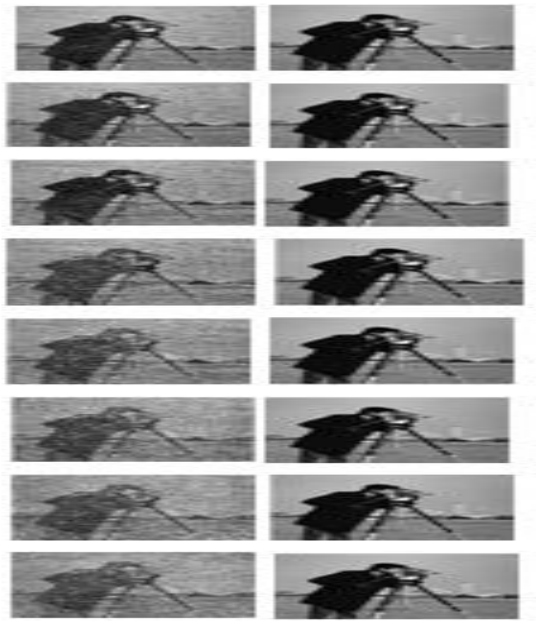


Fig3 : greater white pixels

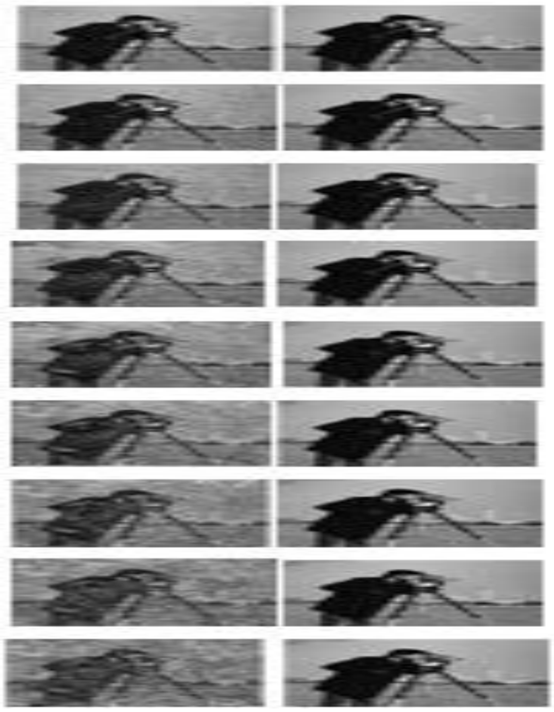


Fig4:Greater black pixels

V.CONCLUSION

The proposed algorithm is examined in Matlab R015a, by giving noise densities from 10% to 90% noise. This paper offers with a unique algorithm that eliminates equal and unequal probability salt and pepper noise in images are proposed. The algorithm suggests excellent results in the elimination of high-density salt and pepper noise in gray scale images. The quantitative and qualitative effects of the proposed algorithm had been found good. The proposed algorithm is Decision tree based algorithm. This algorithm also showed good result in removal of equal and unequal probability salt and pepper noise. Hence an algorithm for the elimination of 3 salt and pepper noise models is proposed.

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AUTHORS PROFILE

Vasanth Kishore Babu received Electronics and Communication from Arulmigu Kalasalingam College of Engineering affiliated to Madurai Kamaraj University with first-class distinction in 2003. He later got M.E degree in Applied Electronics from Sathyabama University in the year 2007 securing university Fifth rank. He completed his PhD from the same university in the year 2014. He acted as the project leader with the prestigious Sathyabama Nano Satellite for the 25-year-old Sathyabama University. He currently works as a Head of the department in Department of Electronics and Communication Engineering at Vidya Jyothi Institute of Technology, Hyderabad, India. His current research interests include non-linear filtering, image enhancement, VLSI signal processing for image processing algorithms, and space-qualified systems. He has published more than 50 research papers in reputed journals and conference proceedings.

Shirisha.N , PG Scholar, VidyaJyothi Institute of Technology, Aziz Nagar, Hyderabad, Telengana, India

Naveen Kishore Babu CEO, Link Buffer Studios, CANADA